Landsat CVT Sentinel-2a MSI On-Orbit Radiometry Analyses and Observations

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Background

- Sentinel-2a launched 23 June 2015
- First Images acquired 27 June 2015 – released 29 June 2015
- First on-orbit sample data products available 16 July 2015
- S2A Expert Data Users Hub opened to CVT (level 1C commissioning phase data) 10 Sept 2015
- S2A Expert Users Technical Session (preliminary results presented) 29-30 Sept 2015
- S2A Scientific Data Users Hub (operational Level 1C) open to public 3 December 2015 for new data – older data to be reprocessed and added to hub

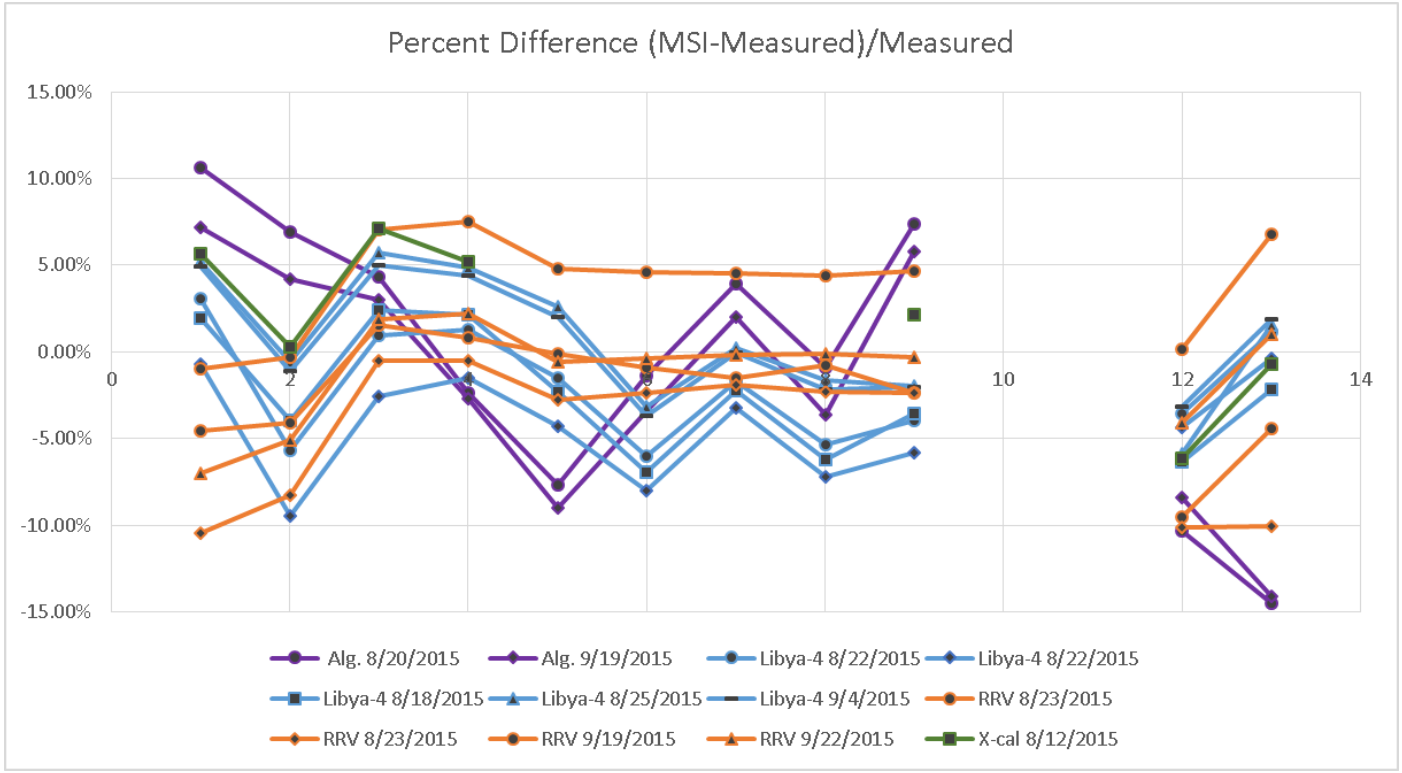
Considerations

- Limited data sets available for analysis
- Data processing system in flux during study
  - Limits ability to assess stability of data
  - Limits applicability to current operational data
  - Changes not always known/understood by CVT
- Analyses all performed on processed Earth data
  - Evaluation of processed data quality as opposed to sensor performance

Results

- Radiometric Calibration
  - Vicarious Calibration
  - Cross Calibration with Landsat-8 OLI
- Other Observations
  - Cold Focal Plane Contamination
  - Versions
    - “Physical Gain” parameter in metadata

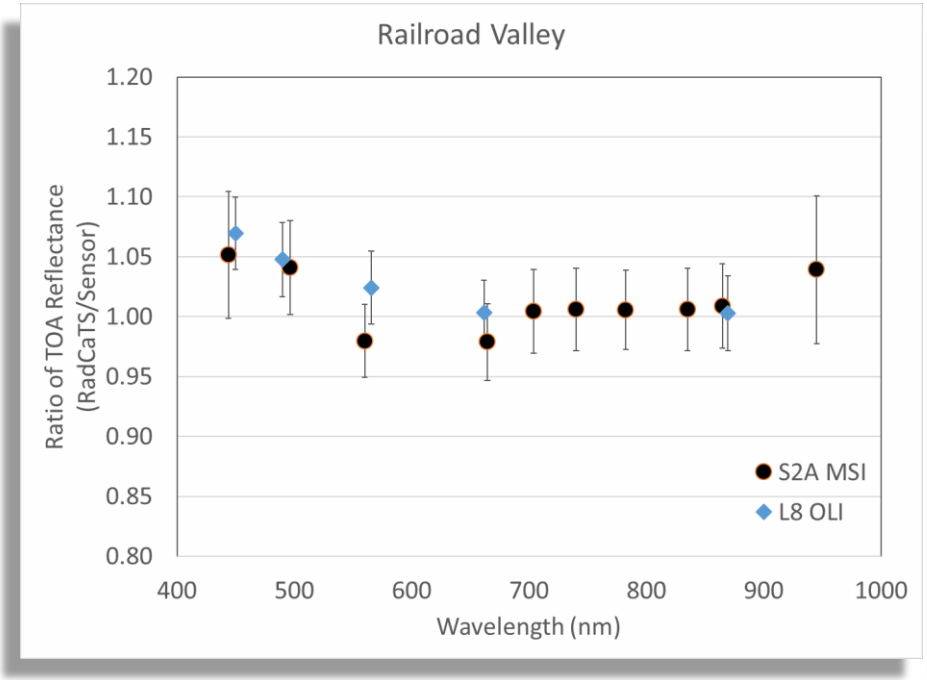
Preliminary Results: MSI TOA Reflectance Comparison

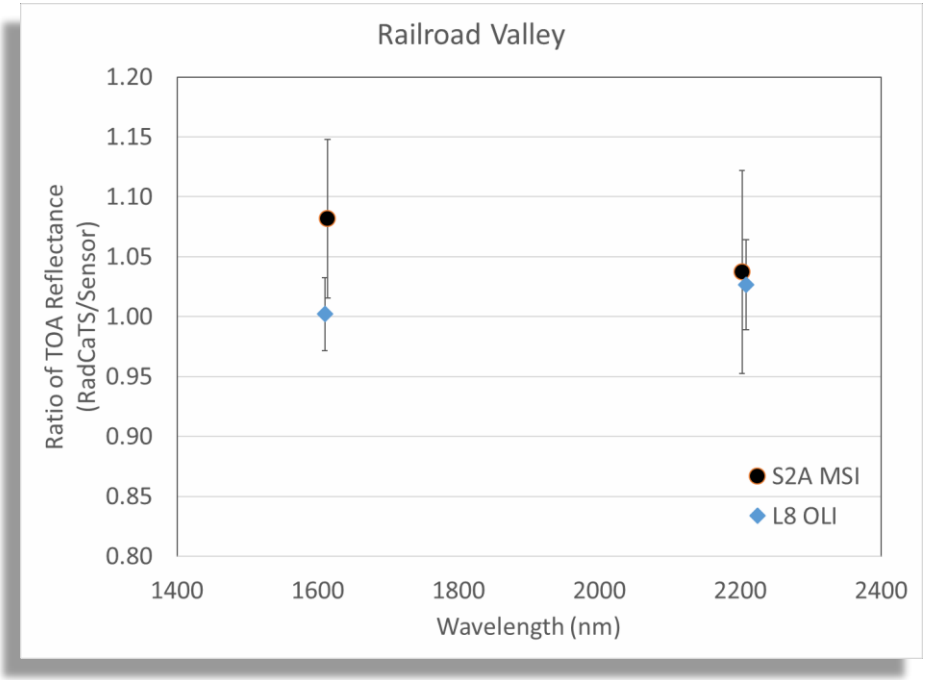


Preliminary results from September 2015; expect update after review
Three sites (RRV, Libya-4, Algodones), three techniques (Xcal L8 OLI, vicarious with and without ground measurements; generally consistent ±5%)

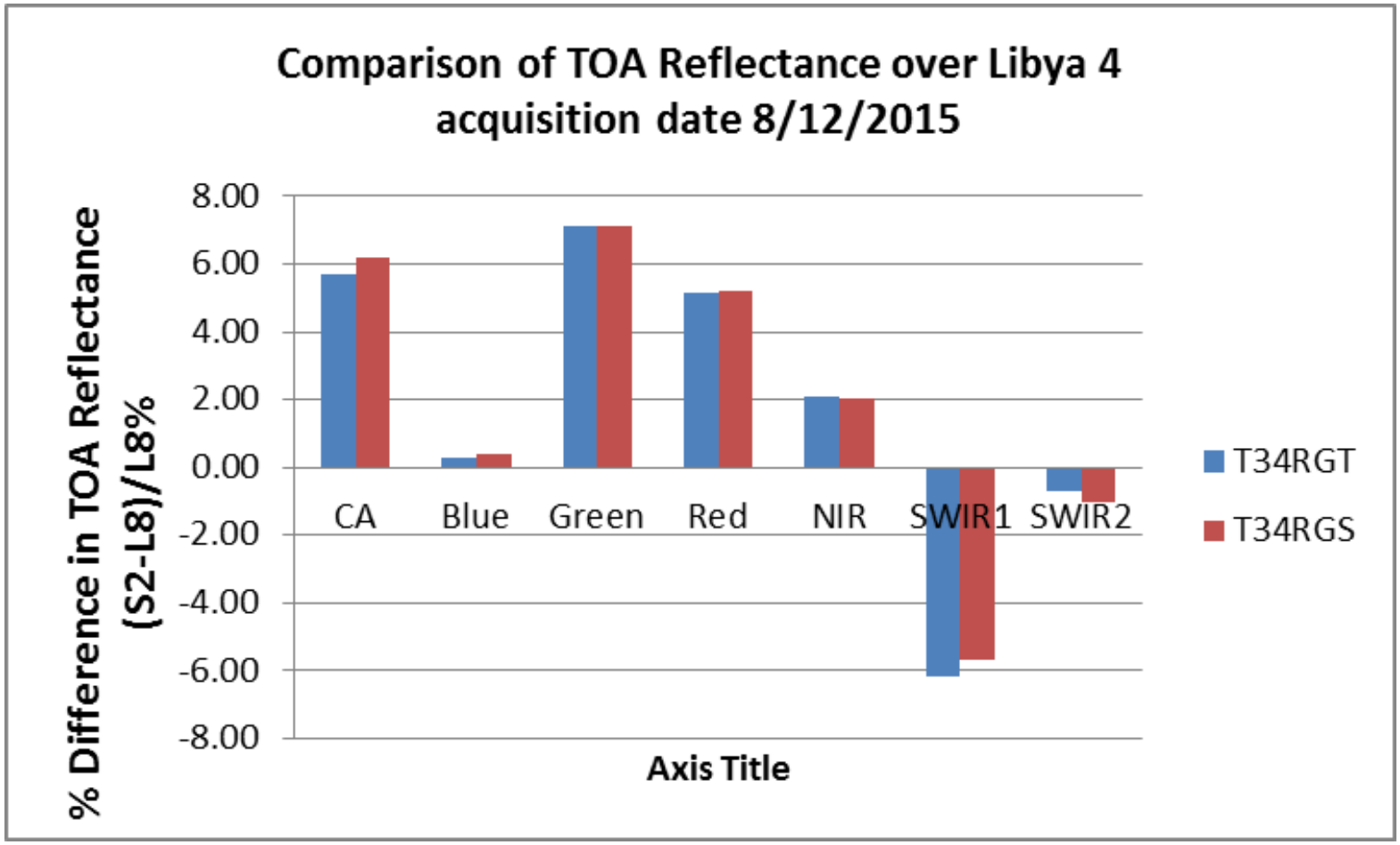
University of Arizona RadCatS: OLI & MSI

- TOA reflectance
- OLI: Mar 2013 – Nov 2015, 14 dates
- MSI: Aug–Oct 2015, 4 dates (pre-operational gains)





OLI/MSI Difference in TOA Reflectance



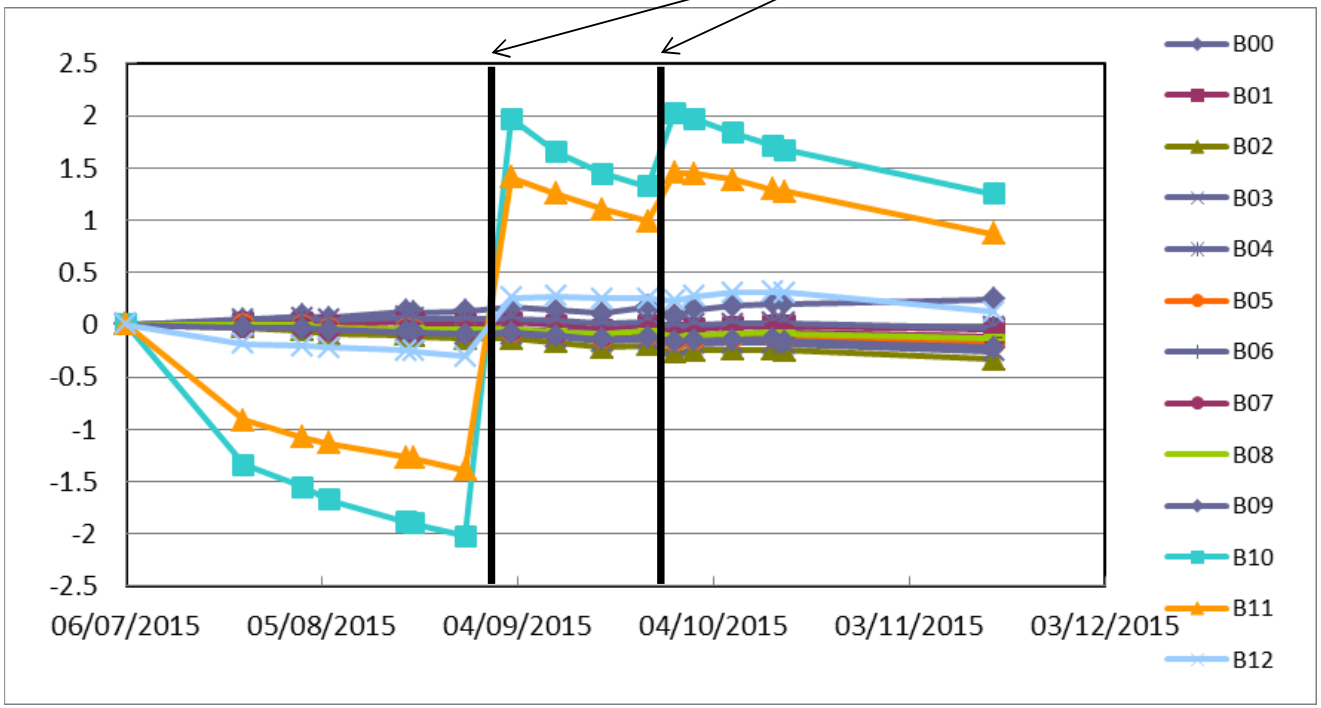
USGS results. (SDSU results over same scene consistent to within 1% except red band)

MSI Radiometry Comments

- MSI SWIR bands are on separate cold focal plane (CFP)
  - Radiometric gain variation akin to Landsat-5 TM has been observed (reported by CNES at SPIE, CEOS)
    - Decrease in responsivity with time that recovers with warm up of focal plane (±2% effect to date with several cycles during commissioning)
    - Presumably due to contamination build up on CFP
    - Not clear if processing currently adjusts for this variation or the plans during operations
- "Physical Gains" reported in metadata
  - Awaiting confirmation of exact meaning-presumably a responsivity measure
  - These gains have varied with processing version
  - Awaiting clarification

Absolute radiometric calibration

Nominal Method : On-board diffuser



→ **Very good stability of the VNIR bands**

→ **Very good repeatability of the results which allows us to monitor the evolution of the radiometric response of the SWIR bands**

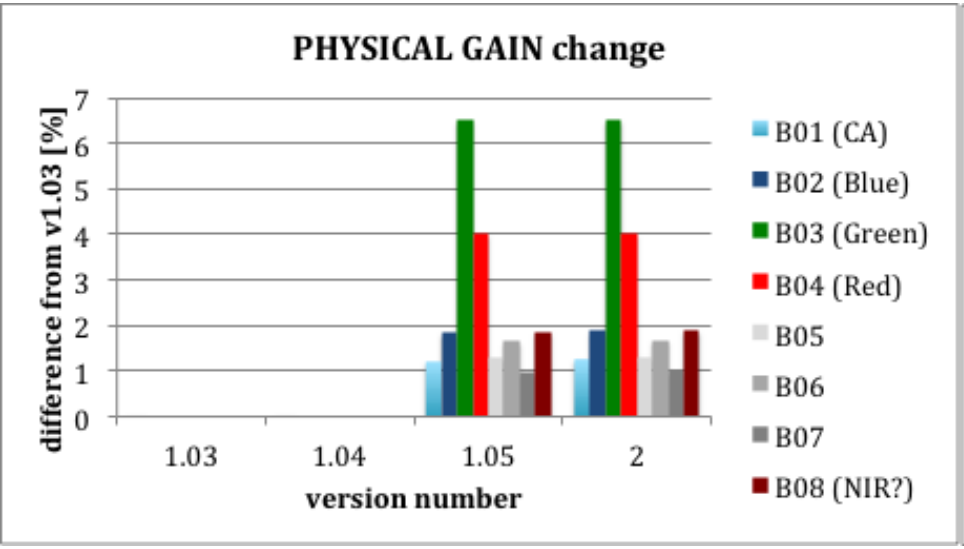
S2A_CEOS_IVOS_19112015.pdf (presented at CEOS IVOS meeting by S. Lacherade)

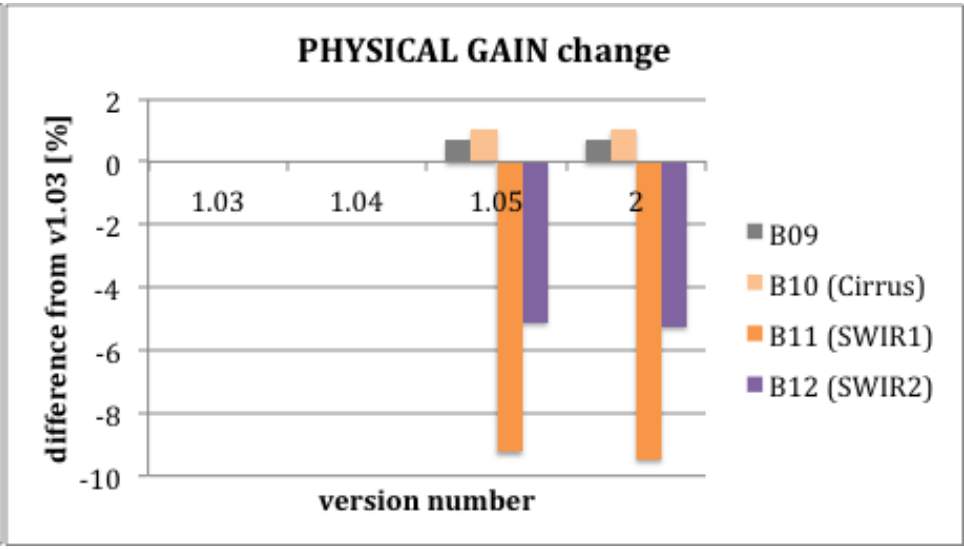
Tracking Physical Gain

- Physical gains are stable from v1.03 to 1.04
- We have one scene with v1.05. The gains have changed by a lot.
- We have several scenes with v2.0.
  - The earliest scene has gains that match the v1.05 gains. (processed on Nov 26).
  - Three later scenes have gains that are *slightly* different than the v1.05 gains. (processed Dec 1 or later)
  - The v2.0 SWIR band gains have not changed over the 11 days that the 3 later scenes cover. (Dec 1-11)
    - This is significant because we don't know if they are going to try to correct for the outgassing effect.

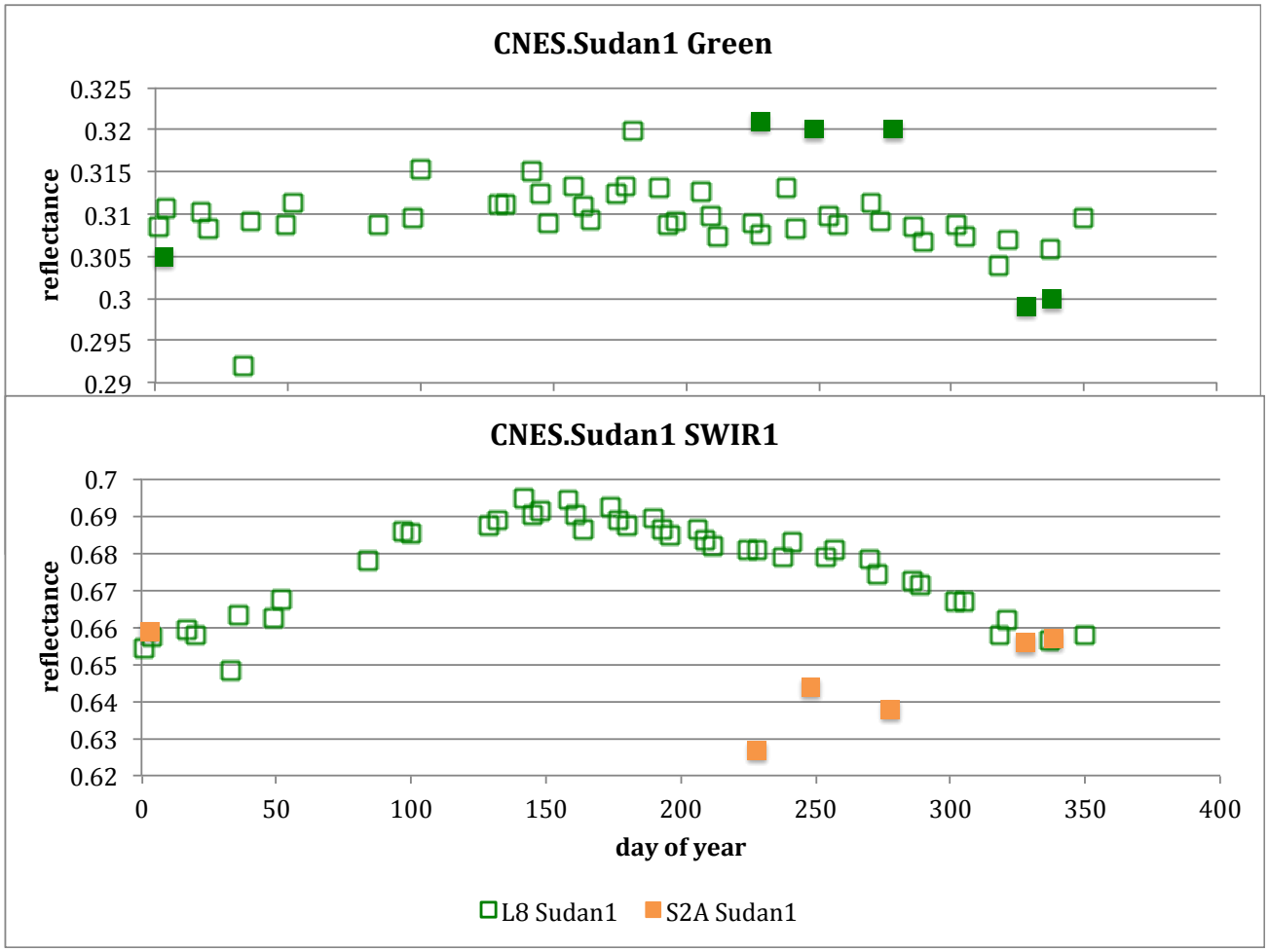
Tracking Physical Gains: Version Number

- Physical Gain change from v1.03 as represented by my RRV scenes.
  - The v2.0 scene with the v1.05 gains is not a RRV scene.





Newly Processed Data Over PICS sites



No SBAF applied

Summary

- Initial radiometric results for the Sentinel-2a MSI data are encouraging
  - Initial data appear to be at or near requirements
  - Updates appear to be bringing data closer to Landsat-8 calibration
- There will be some period of time before the data will achieve the best performance and consistency
  - Stabilization of radiometric processing/treatment of contamination phenomena
  - Expect that these will be achieved per plans by Sentinel 2B launch (mid 2016)
- Landsat CVT will continue to monitor and update analyses when appropriate